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THE CANNON

February 26, 1980 | University of Toronto Engineering Society | Volume II, No. 6

Inside the Microprocessor

FOUR broad classes of computer are available today. These are large mainframe computers (wall-to-wall computing!); small to medium sized mini-computers; microprocessors; and programmable controllers. The last three types have basically similar capabilities.

Programmable controllers are useful in that they can generally be 'programmed' by a company's control engineer, usually in a ladder network form. Microprocessor systems benefit from economies of scale. Although there is no argument with the statement that a microprocessor can be bought for /10, that is only part of the story.

All computer systems are composed of hardware and software. The main hardware consists of a memory, a central processing unit (CPU) and the peripheral equipment.

The CPU executes the instructions that are required to perform the particular application the computer is designed for. These instructions constitute the software and are held in the computer's memory, the size of which is measured in thousands of words, which is denoted by K—thus a computer may be described as having a 4000K word memory. Word length is measured in 'bits.'

Computer hardware (or machinery) connects the memory to the outside world but the computer obeys only software instructions. Unfortunately, the CPU needs instructions in a very simple form and reducing them to this form is very labour intensive. Thus, as hardware costs have nosedived, software costs have rocketed. In order to reduce system costs, manufacturers have developed standard software packages that are increasingly being used in many different applications.

Software packages remove from the programmer the chores associated with controlling and managing the computer hardware, thus allowing him to concentrate on the application problem and not waste time on the computer itself.

The first computers were driven by valves. But with the advent of the transistor, the IBM company went all out and developed their own logic for it and thus leapt miles ahead with their IBM 330 computer which was reliable and much better than anything else around at the time.

Then integrated circuits tended to replace the transistor and brought with them a new technology, that of the minicomputer. And it's been the same story with the Large Scale Integrated Circuit (LSI) which has replaced the integrated circuit and transistor and led to the development of microprocessors.

The Intel 8748 is a true single-chip microcomputer containing all the functions required in a digital processing system. A single 40 pin package contains an 8 bit CPU, 1024 words of program memory, 64 words of data memory, 27 input/output lines and an 8 bit timer/event counter. (Intel)

Thus, although each technological advance has enabled the development of new computer hardware, it has also contributed to the existing hardware and in some cases has totally replaced the previous technology in that machine.

Figure 3 gives a graphical representation of the most critical parameters to be considered before a computer application is tackled. From this it can be seen that the minicomputer is typically used for low volume, complex applications whereas the microprocessor is used where a higher number of units are required and complexity is above that of simple hardwired logic tasks.

Both have important roles, but it is the general purpose minicomputer which has been developed to its full by manufacturers who now offer incredible power in 'mini', in fact. These machines today are capable of previous mainframe applications. Yet in many respects their prices are still very much mini standard.

So where do these minis fit in today's computing? One area is certainly as a central machine for manufacturing environment. These computers can draw together shopfloor information and provide not only a controller and consolidator of information but a computer capable of running many systems applicable to a manufacturing environment.

So to the microprocessor. The microprocessor appeared as a result of technological development of large scale integration (LSI). This made possible substantial reductions in the cost and size of digital logical circuits.

A microsprocessor is simply the elements on an LSI chip which perform the calculations for the central processing unit. It has no memory and no input/output devices.

On the other hand, a microcomputer is a microprocessor with additional circuits for memory and input/output and with software for controlling the operation of the microprocessor.

GRADS: Your Big Party Is Coming
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A Student Speaks Out

Now that the Canadian Accreditation Board (CAB) has visited the Engineering Faculty at the UofT to pass critical judgement on the educational process being carried out, perhaps each and everyone of us undergraduates should also examine "the system" with a critical eye.

What one sees is not overly encouraging and those who have left the UofT in disgust have more acidic insults. The main problem, it seems, is that although most students, professors and government experts agree on the aim of a university engineering education, no consensus exists as to how this goal is to be met. As a result, the education of undergraduate engineering students has evolved into a system which is convenient to those yielding the proverbial big stick. Needless to say, the students' aspirations carry little clout, and this is why so many concessions to convenience are made. Perhaps it might be worthwhile to outline some of these concessions.

The most basic compromise made by this university (and many other universities as well) is to give in to the numbers game. Pedagogic experts agree that the best education occurs when the student to teacher ratio is low, yet this university finds no problem in reconciling lectures, in which the ratio may be 100 to 1, as the primary tool of information transfer between professor and student. The reason for this compromise is that government funding is doled out in a "per head" basis, where a university gets money in direct proportion to the number of undergraduates manufactured.

The next compromise is textbook idolatry. This misguided doctrine states that the easiest way to enrich the minds of undergraduates and prepare them for a career of creativity is to imprison their minds between the covers of series of textbooks, assuming that all seeds of knowledge can be printed on a finite number of pages. This worship of the textbook is perpetuated since it allows a world

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the Cannon

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Submissions are welcomed; please type. The deadline for articles and announcements for the upcoming Tuesday's issue is Friday at five. The editors reserve the right to edit letters.

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THE CANNON is a publication of the University of Toronto Engineering Society. It is published to announce Eng Soc events, discuss Faculty and educational matters, present technical and University news and to be an open forum for the opinions and interests of members of the Faculty. All those who would like to help with THE CANNON are most welcome.

Editorial

How come we never see the CANNON anymore? I've asked myself that question many times before. However there is a simple explanation that I've wanted to write about before and this is as good a time as any.

Putting out a paper is no easy job regardless of the number of pages, contrary to what many believe. It involves a lot of time, editing articles, layout, proofreading, and other endless tasks. But the most important thing that is necessary is material!

One of the policies of the CANNON is to inform the faculty of events occuring in it. Another is to provide interesting engineering related articles. However where does one obtain articles from? There are two main sources; from students and professors in the faculty, and magazines and journals.

It seems that the major contributor is magazines and journals. Why? Because there seems to be a lack of interest from the students and professors. This year there have been only a few people writing for the CANNON. What about everybody else? If we can spare a couple of hours now and then to contribute, why can't anyone else?

Instead, we have to resort to not publishing, or to magazines. We don't like doing this. Why publish material already published? What I'd like to see in the future is more contributions. I'm not asking for articles every week, just one from many different people. If you don't have a topic, we can arrange something for you.

Otherwise, if this trend keeps up the CANNON won't. Another item brought to my attention is the amount of electrical content in the paper. But then, the few contributors happen to be mainly in electrical. Naturally the CANNON is mainly composed of electrical content.

So for all you people in engineering let's see some more contributors. Where's your Skule spirit?

Placement Centre Needs Money

February 19, 1980

Dr. J.M. Ham
President, University of Toronto
Simcoe Hall
Toronto, Ontario

An open letter to Dr. James Ham, President, UofT.

Dear Dr. Ham:

I am writing this letter on behlf of the University of Toronto Engineering Society, where I am Chairman of the Employment Committee.

Each year, the various departments that make up the University of Toronto make their budget submissions to the University Government. The process of reviewing these submissions for 1980-81 is well under way. One of the proposals that will be considered is that from the UofT Career Counselling and Placement Centre (CCPC).

Requests from the CCPC are two-fold. First, they have requested an increase in staff of two placement/counselling officers, and second, an increase in operating budget. We submit to you that these two requests should be approved, as they are required if the Placement Centre is to continue to respond to the demands of the student body and to improve the efficiency of its services.

The CCPC is short of staff. Many times lineups form as users are in search of counselling help and directions. The staff is often under pressure from students wanting to get advice on career questions and job-search problems. An increase in staff is, we feel, needed to make the CCPC's services easier to use and more helpful to users.

The second part of the Placement Centre's budget submission deals with an increased operating budget. This budget, in addition to offsetting daily operational costs, also provides funding for marketing and research programs. The CCPC has an extensive marketing outreach program which promotes UofT students to business and industry, and solicoits prospective permanent and summer job opportunities. This, we feel, is an area where the CCPC must expand. It is obvious that the University must promote itself and its graduates actively rather than letting its reputation speak for itself. We feel increases in the CCPC's operating budget would ensure that marketing programs continue to grow.

Inconclusion, we ask you and the other members of the University Government to approve of the Career Counselling and Placement Centre's budget submission for the 1980-81 academic year.

Yours sincerely,
Dave Neale,
Employment Chairman

A Student speaks

cont'd from page 1

encompassing body of information to be represented by the writing of one author of certain specific facts. In such a format these are easily taught (and learned!) but does the student grasp how these few, finite facts interface with the outside world?

Another all time favourite compromise is the exam as quality control syndrome. In order to determine whether an undergraduate should be turned loose on society, the university puts him/her through a series of "Final Exams". As a result the aim of a student is not to become a worthwhile engineering graduate, but to become an "Exam Acer". Too bad that life is not a series of "Final Exams", but then, exams are a fast, easy and efficient way of absolving the university of responsibility for the actions of its graduates. After all, if these graduates design something which kills people or harms the environment, the universities wash their hands by pulling out their transcripts.

Finally, let us look at the ivory tower effect. The universities have allowed their synthetic learning environment to become so disjoint with the real worl that a newly graduated engineer undergoes a type of culture shock upon entering the work force. The comment that engineers in industry use very few of the equations or methods taught in university is more than just cynicism.

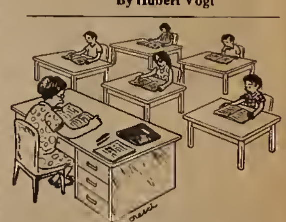
All of this then leaves us with some tough questions to pose to the professors and administrators of this engineering school.

1. Why are not more projects and project-type assignments used as an alternative to the final exam as a means of performance evaluation?
2. Why can textbooks not be demoted to their proper place in the educational arsenal and more of an emphasis placed on real world problem solving?
3. Why could not the entire education of an undergraduate revolve around the completion of several major engineering assisnments? (i.e. as in a system such as taught to engineering students at the Worcester Polytechnical Institute, Massachusettes.)

Until "the system" is changed such that the methods used to achieve the goals reflect the aims of engineering education and not the convenience of those running the system, these questions must be asked and necessary changes must be effected.

If anyone feels qualified to answer the three questions posed, send the reply by campus mail to The Cannon, c/o Engineering Society, 30 St. George Street. Answers addressing the questions will be printed in the next issue.

By Hubert Vogt



"'Any disturbance in a parallel-tuned circuit starts a current oscillating through the coil,' said Dick. 'But the oscillation dies out unless properly timed energy is fed into it,' said Jane. 'Bow-wow,' barked spot."

Introduction to Adhesives

Recent developments in adhesive honding have meant that the technique is now capahle, in some instances, of replacing conventional joining methods such as welding and mechanical fastening. This data sheet summarises the advantages and disadvantages of adhesive bonding and gives a general indication of the type of adhesive to use in given situations. It provides only an introduction to adhesives and the advice of the adhesive manufacturer should he sought at an early stage in the design procedure.

Advantages of adhesive joints

1. A variety of materials, which may have different physical properties (eg. coefficient of thermal expansion, elastic moduli, etc.), can be joined using adhesives.

2. Adhesives may he used to join materials of different thicknesses and they have particular advantages when one or both pieces to be joined are very thin - thin sheets and foils which would he distorted or destroyed by other fastening methods can successfully he joined using adhesives.

3. Adhesive bonding produces a regular surface contour, without protruding holts, rivets, etc.

4. Stresses can he distrihuted more uniformly over the honded area using adhesives. Stress concentrations associated with holt and rivet holes, spot welds, etc., can he avoided. This may mean that thinner materials can he used, with consequent savings on material costs.

5. The high damping capacity of adhesive honding and the elongation properties of many adhesives allow stresses to he absorhed, distrihuted or transferred. Adhesive honded joints thus exhihit good vibration damping properties (which may help increase sound insulation) and good flexibility.

6. Adhesively bonded joints are sealed against ingress of moisture and chemicals. The joint may act as an electrical insulator, therehy possibly reducing galvanic corrosion.

7. In some applications, the simplification of the joining operation hy using adhesives can lead to cost savings.

Disadvantages of bonding

1. The strength and durahility of the joint are highly dependent upon processing conditions, including surface preparation, curing procedure, etc., which cannot easily he inspected after the joint has heen assemhled. There are few satisfactory non-destructive test procedures for adhesive joints.

2. Particular care must he paid to joint design, as most adhesive bonds are very prone to cleavage failure. Many thermosetting adhesives have low peel strength and thermoplastic adhesives may creep under sustained loading. Advice should he sought from the adhesive manufacturer hefore the joint design is finalised.

3. Most adhesives are unahle to operate at high temperatures. Thermosetting polyimides and modified epoxies are usually satisfactory up to 250° C. Silicates may be used at temperatures up to 1500°C but they are prone to he brittle and have limited adhesion to metals. If the joint is likely to encounter high temperatures, the advice of an adhesive manufacturer should be sought at the design stage.

4. Residual stresses may he present in adhesive joints cured at high temperatures.

5. Full hond strength is not ohained until after curing and this may cause difficulties in assemhly. In addition, special jigs and fixtures may be required to keep the joint under pressure during curing.

6. Curing of the adhesive may require quite high temperatures, necessitating the whole component heing heated in an oven.

7. Many adhesives are toxic or inflammable, or they may give off toxic or inflammable vapours during curing.

Types of adhesive

Natural. Natural adhesives are of vegetahle or animal origin. Vegetable glues (such as starches, dextrin and gum arahic) are mostly limited to the joining of paper, cardhoard, foil and light plywood. Animal glues have higher joint strength and degradation resistance and are often used for woodworking.

Most natural glues are supplied as solvent-hased liquids which solidify on loss of solvent. They may he watgerproof hut are not weather resistant and may he prone to hio-degradation.

Thermoplastics. Thermoplastic adhesives soften when heated and may he prone to creep under stress. They have higher hond strength than natural adhesives and are highly resistant to moisture and hio-degradation.

Hot-melt thermoplastic adhesives can he supplied in the form of tapes, films, powers, rods, pellets and hlocks. They are usually applied by special equipment which warms the adhesive above its softening point; curing usually takes place at room temperature.

Thermoplastic adhesives hased on plasticised polyvinyl chloride can he successfully applied to oily metal parts without cleaning the surfaces to he honded. The adhesive is cured at elevated temperature.

Cyanoacrylates are low-viscosity fluids which solidify rapidly in a joint when moisture on the surface heing honded catalyses polymerisation.

Thermosets and two-part polymers. Thermosetting resins solidify through chemical reaction or the application of heat. Once set, they cannot be re-softened and re-solidified hy heat cycling. Some may be cured at room temperature hut many need heating. Some thermosetting adhesives can be used for joints which will operate at elevated temperatures.

In general, thermosetting resins provine higher hond strengths than other adhesives and have good resistance to creep. The peel strength of the joint may he low, however, and the hond may he brittle and have low impact strength.

Thermosetting phenolic resins are mainly used for woodworking but have good adhesion to metals and glas. Heat and pressure are required to cure the adhesive.

Epoxy adhesives have a range of applications and are often used for thestructural honding of metals. They are usually supplied as two-part formulations which must he mixed before applying and which may require heat to promote curing, although many can he cured at room temperature over a longer period. Light contact pressure during curing is sufficient to secure a satisfactory hond.

Urea and melamine formaldehydes are extensively used for honding of plastics and wood. The urea types are

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Microprocessors

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Bearing in mind the products which use microprocessors, it might seem that they are only used in dedicated applications hut this is not the case.

It is software that has always given the computer its flexibility. Software or machine instructions are essentially replacements of hardware components and it is easy to show in many applications that a microprocessor, together with 2K hits and read-only-memory (ROM) could replace some 13 to 25 integrated circuits (ICs).

In electronics for instance, hy using switches or gates and hy putting many combinations of these together a hardware controller can be developed. By using ICs which have a numher of gates in each device the joh is made easier. But the controller has to he huilt and tested every time, thus the hardware is a recurring cost.

If a microprocessor is used on the other hand, once the software has heen developed, it is a non-recurring cost. It can easily be duplicated or stored in the memory of any numher of systems. Further, it has inherent flexihility since the software can easily he changed. This is perhaps the most significant advantage of microprocessors in systems control design.

Microprocessors are not usually directly competitive with minicomputers, since their markets are essentially different. Although applications can and may overlap, the methods of implementation differ. This is because micros are 'off the shelf' components and are essentially all that the huyer gets from a manufacturer, apart from the operating manual and his best wishes!

Minicomputers on the other hand, are sold as systems and come with a full support package, which often includes a great deal of hand-holding hy the manufacturer. The system will often be complete with all sorts of peripherals and maintenance packages.

But the times are changing. Things are already happening in the micro market and the area of software support is hound to grow considerahly — as anyone who had a minicomputer in the mid 60's will know.

In fact, far from heing a battle for supremacy, some important marriages are taking place. Firstly, the major mini manufacturers are producing their machines hy using a small collection of microprocessors. Secondly, we are seeing machines controlled on the shopfloor by microprocessors.

This is a major and significant break-through in itself. But add a minicomputer acting as a controller and the flexihility is enormously increased. This enahles not only data collection and master alarm control, hut also the ahility to rapidly change the machine control programmes which are in the microprocessors.

This marriage of mini and micros is inevitahle and will give the production engineer the power and flexibility to use his imagination in manufacturing.

Reprinted from Process Engineering

Engineering Jocks

The Engineering Athletic Association (E.A.A.) organises sporting activities for our faculty. Engineers were entered in twelve sports: hockey, hasketball, lacrosse, volleyhall, rughy, track and field, swimming, waterpolo, soccer, squash, skiing, and foothall (touch and contact). A new sport, called Engineering Frishee, has started-up this year and hopefully will continue next year. Also, some interest has heen expressed in floor hockey and next year may see the introduction of an intramural league competition.

Women in Engineering have heen active in five sports: touch football, hockey, innertube waterpolo, volleyhall, and hasketball. Dale Kerr, the Women's Sports Commissioner for the E.A.A., has done a super joh and with the help of a second WSC, she hopes to enter our ladies in squash, and field hockey.

Of the seasons that have ended, Skule achieved: for 79-80, Track and Field Champions, Swim Meet Champions, Lacrosse Champions, Rughy Finalists, Basketball Champions (78-79), Sr., Hockey Finalists (78-79), and Women's Baskethall Champions (79-80). The sports of last year are mentioned here hecause they occurred after the Annual 'S' Dance, which hrings us to.....

"**The 1980 Annual 'S' Dance and Awards Presentation** in Recognition of Engineering Athletes." Awards are presented to memhers of championship and finalist teams, to most valuable or outstanding players in their sport, and to engineers who have accumulated the required points towards the Skule Letter: 15 points for the Chenille 'S', and 40 points for the Bronze 'S', (which is awarded to those in their graduating year only).

Admission to the 'S' Dance is free to all engineers and their dates, and a great evening can he made of it. Take your date to a nice restaurant for dinner around 5:30-6:00, then come to the 'S' Dance around 7:00-7:30, followed hy the awards presentation at 8:00, and dancing at 9:00. Later in the evening, a complimentary buffet shall be served. An excellent band has heen hooked to provide you with great dancing music. And rememher, the dance is FREE! Tickets are available at the Engineering Stores.

No other college or faculty offers more for their students than does your Engineering Athletic Association, an affiliate of the Engineering Society. Some people even claim that athletics is a waste of time and money. However, when you consider that the amount spent is small in relation to the number of participants and the henefit that they derive, most people view the E.A.A. as indespensihle. The amount of time spent in athletics works towards giving the student a hreak from the classroom, which in turn gives the student a well-rounded, mature personality - something like the administration says that your non-tech is supposed to do. (ha-ha)

So take a hreak — Play Ball!

Microcomputers are Not as

By Eric Hartwell
Steel Breeze Systems

Everyone has heard about microprocessors by now. They're everywhere: lurking in your calculator, playing pocket football, optimizing the engine in your car, running your computer terminal, beeping and zapping in a pinball machine, switching the lights in your room. The reason is simple. They do the job faster, better and cheaper, and as a result they're becoming essential in all branches of engineering.

It's too bad the name seems so intimidating. A microprocessor is merely the brain for a small computing machine, and we all know that machines are really dumb. Because microcomputers are small, they're easy to understand; because they're built with the latest integrated circuit technology, they're easy to build and use. **Any engineer can design a microcomputer system,** and most can build one. The intent of this series is to show you how.

Let's start with the basics. For our purposes, a microprocessor is a single integrated circuit (IC) component containing the basic control logic for building a small (micro) computer. Usually you need other components for building a functioning computer, though it's even possible to get *everything on one chip* (see figure 1).

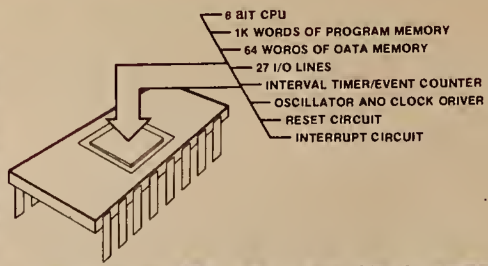

Figure 1. The Intel 8048/8748 is a single-chip microcomputer containing all the functions required for a simple controller.

One measure of the capability of a processor is the size of the 'words' it uses. Word size is measured in bits, where each bit can have one of two values (commonly on or off, or high or low voltage). A four-bit word can specify 2x2x2x2 or 16 possible combinations, and an eight-bit word or two four-bit words in sequence can specify 256 different commands or data values.

Commonly available microprocessors range from four bit (in your microwave oven, tape deck or coffee machine), to eight bit (typical 'personal' computers, fancy TV games), twelve bit (usually simulating minicomputers), and sixteen bit (the big leagues for micros). There are also such oddball creatures as one bit processors, though the application for such specialized machines are somewhat limited.

For general purpose use in engineering the eight-bit machines are currently the best choice. This is not only because of cost and capability considerations, though they do score well on these points, but because they're readily available and have all kinds of backup support. In fact, almost all of the low-cost one-board computers on the market have eight-bit processors.

If you want a microcomputer for number crunching, accounting, or playing Star Trek it's far better to go down to the neighbourhood computer store or Radio Shack and buy one ready-made. Not only does this give you an assembled, debugged system that's ready to plug in and run, but there's an enormous amount of software already written and available at reasonable cost. Why bother re-inventing the wheel, especially when the Klingons are waiting?

On the other hand, general purpose microcomputers aren't likely to do exactly what you want for automating a specific application, and here's where the custom design comes in. In many cases it's just as easy to build the entire system from scratch as it is to modify something off-the-shelf to do something it wasn't really intended to.

Let's consider a specialized but still typical controller application, the traffic light. (This could just as easily be a pinball machine, or a chemical process controller, an automatic lathe, a cement mixer, or whatever.) There are a number of inputs (from car sensors and pedestrian buttons), a number of outputs (to switch the lights on and off), a clock (to count the time between changes), and possibly some communications lines (to 'talk' to other lights along the street or a central computer).

Back in the dark ages, all this was done by motors and gears, except the communications link, which was too complicated to think about. More recently, it took a maze of electronics with varying degrees of mechanical assistance. Now, using the most current technology, the entire control function can be crammed into a single IC microcomputer chip (see figure 2). In fact, Toronto's traffic lights are currently being replaced with similar one-chip controllers.

The microcomputer itself can't handle the high power in switching a 600 Watt light, so the system still needs external transistors. However, the hardware design of the controller has been reduced to designing only this customized 'real-world' interface. The design of the actual control system has been converted to writing a computer program which can be easily changed as the bugs are smoked out.

This single-chip implementation is clean and elegant, but there are limitations to what can be crammed into a square centimetre of integrated circuit, and even more to what you can do with a restricted number of pins on the package. In most applications the microcomputer will need more than one part.

The same controller could have been built with a microprocessor and several

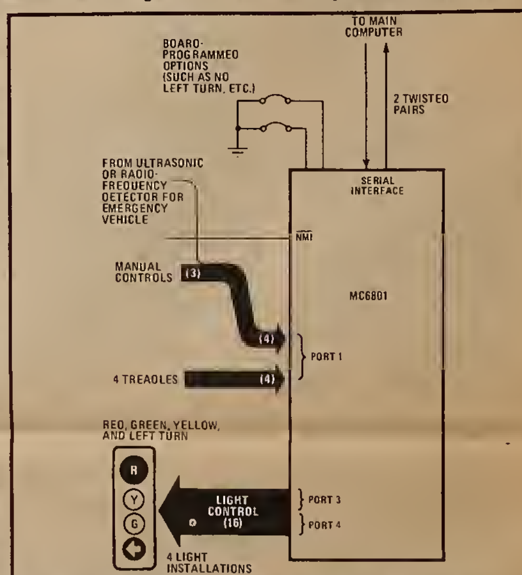

Figure 2. Traffic light controller using the 6801 single-chip computer. (Electronics, December 6, 1979)

Complicated as They Seem

peripheral chips. The basic components of the traffic light system are the processor, the inputs and outputs, the program memory, some temporary data storage memory, a timer, and a serial communications link. It won't come as any surprise that if you can fit all of this onto one IC, you can fit various subsets of it onto one as well. However, for the sake of example we'll consider the extreme case where each function has its own part.

Figure 3 shows the fully designed microprocessor system. Wasn't that easy?

The electronic design is identical to the functional block diagram, and almost as easy to do. The only hard part is picking the exact components to be used, and to that you have to know what's available.

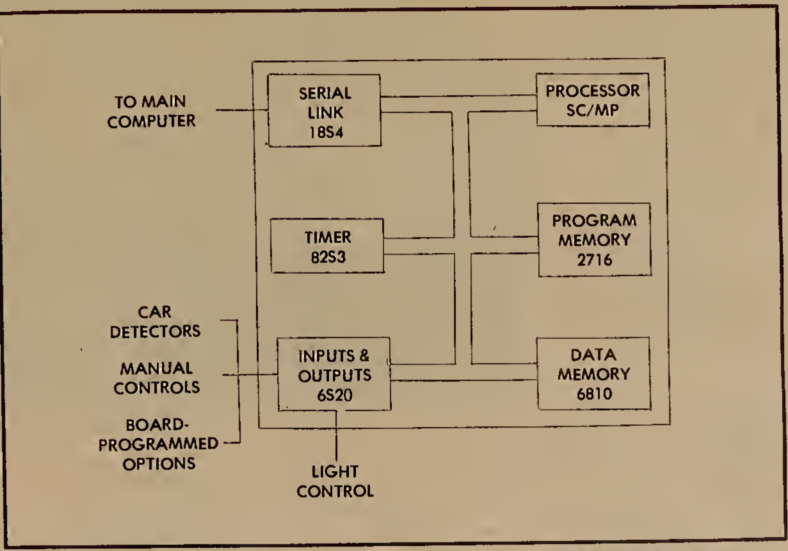

Figure 3. Traffic light system using peripheral components from assorted microprocessor lines

A) The Microprocessor

There are about a dozen commonly used eight-bit processors suitable for this application; each is different to some extent, and each has its own good and bad points. Each manufacturer claims that their part is the best, and people who have learned the details of one particular processor are often rabidly fanatic about agreeing with this.

In reality, though, it really doesn't matter which processor is picked for a control application; they're all capable of doing the job. The choice depends on which will simplify the programming the most and take the fewest external parts to perform the function. In practice, of course, it's even more important to choose one that's easy to buy, develop the programs on, and test with the facilities you have available.

B) The Memory

Fortunately, microcomputer memories are pretty well standard, and for control applications a single IC is usually sufficient for the program storage. For the data there's more choice, but since controllers generally don't use much memory it depends mostly on what is available cheaply enough on one or two ICs.

C) The Peripherals

The peripheral components are what really make or break the system. Each microprocessor manufacturer also makes a series of parts to interface the outside world to his processor. What most designers seem to forget is that a timer, for example, made for the Intel 8080 series performs the same function as one for the Motorola 6800 series, and from a system viewpoint they're interchangeable.

The peripherals should be picked for the function, not for the name on the package. It's often possible to find a part from another line with extra features that make it better suited to your application. Therefore, undoubtedly one of the most useful tools for building a microcomputer system is familiarity with the types of processors and peripherals available, and preferably access to a complete set of data books.

Naturally, there's a catch. Just as microprocessors are different from one another, they're different in the way they connect to their peripherals. You can't just plug an 8080 part into a 6800 system and expect it to fit, because it expects slightly different control signals.

On the other hand, the interfacing is usually quite simple and requires at most a few logic gates or a bit of ingenuity. The potential rewards far outweigh the nuisance, especially when you consider such goodies as programmable slave microcomputers.

In part 2 next week we'll take a closer look at cross-connecting processors and peripherals for some common microprocessors.

Build Underground: Save Money

Use of underground space in urban development is often the more economical solution, when total cost benefit and the future value of energy savings are taken into account. Sweden, with its hard rock and cold climate, has pursued this line for many years. Next June more than 1500 delegates will gather in Stockholm for Rockstore 80, the first international symposium on exploitation of subsurface space.

Surplus heat from a steel mill, heat from refuse incineration, energy from solar reflectors and possibly wind-power, will be stored in a 50,000 m^4 underground water-fille cavern and used to warm the homes of between 25,000 and 30,000 people.

This district heating project for an industrial city of the near future, planned for central Sweden, will soon pay for itself at today's oil prices.

"Many engineers and architects realise the benefits to be gained from going underground," says Magnus Bergman, secretary general of Rockstore 80, "But, unfortunately, they have not succeeded in reaching the policy-makers. Despite the success of subsurface space utilisation in a number of places, it is still to a large extent unheard of and unused."

"It is the legislators and administrators who must transform the technology into policies that the public will recognise as beneficial and acceptable," continued Bergman. "Rockstore 80 will, hopefully, initiate this vital dialogue."

But are techniques developed in Sweden, with its cold climate and plentiful hard rock, applicable to this country? "Can we afford not to use subsurface space?" asks John Leeney, consulting engineer specialising in tunnelling, and a member of the committee of the British Tunnelling Society. "Our dying cities are being revitalised, and often the underground solution is the more economic one.

"We must take into account the gross as well as the short-term cost benefit, especially the future value of nergy savings," says Leeney. He cites the example of a south coast sewage works, where there is a choice of boring a tunnel and letting gravity do the work, or of pumping over a hill "for all time." The cold store at Nine Elms, London, "exposed to every warm wind that blows," would be more economical to run if built underground and out of sight, argues Leeney.

Sweden has been storing oil and other necessities in subsurface facilities for more than 30 years and reports three main benefits:

- low construction costs;
- low operating costs;
- considerable advantages in exterior environment, stability of interior climate, and energy consumption.

The oil storage installation at Sullum Voe, Shetland Islands, could have been built underground at the same cost, according to Magnus Bergman. It would have taken 20% longer in construction time, and the

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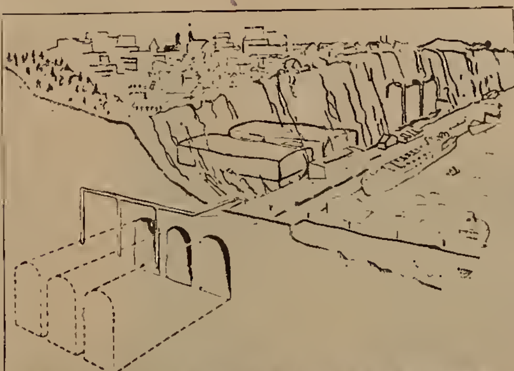


Underground storage in a harbour area includes petrol (left), cold store for foodstuffs (centre) and grain silos on the right

Sewage plant example

Siting of a sewage treatment plant requires careful consideration. Access to a suitable recipient is one limiting factor. The area to be served and the existing pipe network are others. In addition a site has to be found of sufficient size, one which is not subject to restrictiions for environmental reasons.

When nine municipalities in the northern part of Stockholm decided to co-operate on making arrangements for sewage treatment the above equaton did not work out. There was a very suitable outlet into the Baltic of the third largest lake in Sweden, the 1140 ha Lake Malaren.

Objections

However, the shore areas were hilly and densely built-up, and the local house-owners were hypersensitive to any kind of negative impact on environment. The answer to this problem was to go underground. Below a hill at Kappala, located close to the point most suitable for the outlet, sufficient space was available for the treatment tanks and the sludge treatment plant.

On the surface, only buildings for administration and for some technical purpose can be seen. The plant came into operation in 1969 and is designed to serve a population of 450,000. Today it is working at 80% of its capacity. There is sufficient space in the rock to double the size of the plant.

Waste water is led from the nine municipalities to Kappala via pipes and a system of tunnels (length 60 km, section 4-8 m^2).

Tunnells were chosen for these reasons:

- the legal right to pass below anyone's property made pipe-laying simple;
- impact on the environment from traffic etc., during the construction phase would be kept to a minimum.

The plant is operated from a central control room with the aid of a computer. Thus the process is controlled according to the volume and composition on the waste water to be treated. After digestion and dewatering, the sludge is sold for use in agriculture.

Ventilation

The underground location necessitates considerable lighting and ventilation. Comparisons with plants located on the surface however, show that energy consumption is hardly affected by the choice of location - other items of cost being important to be affected.

In fact, underground siting is an avantage since the effects of climate are removed. Somewhat lower consumption of chemicals is achieved as well as less variation in process efficiency.

For reasons similar to those in the case of the Kappala plant, some ten other sewage treatment plants in Sweden have been constructed in rock. In fact, a quarter of the Swedish urban population is now served by subsurface sewage treatment plants.

Reprinted from Surveyor Dec/79

Latest Eng Soc News

At its last meeting on February 12, the Engineering Society Council discussed a number of matters, including fees, the newspaper, the Toike, and sex education.

Vice-President: Administration

• Ken Smith announced that the referendum for increased fees had clearly passed. Of 412 voters, 83% were in favour of the Society increase, and 75% for the Athletic increase.

• Nominations for the Eng Soc elections are open until February 24. (See notice elsewhere this issue); rules and regulations can be obtained from Ella, the Society secretary, in the offices. Council appointed Ken as chief returning officer for the election.

• Ken reported that despite his efforts the typesetting system parts had been picked up, and are now being sold by Dana Stonkus. Ken suggested that the Society should take SBS to court.

• A new insurance policy which is more costly, but more comprehensive and better suited to the Society's needs has been adopted.

the newspaper

The newspaper has its offices in the Old Metro Library building through the sponsorship of the Eng Soc, though no money or editorial control is involved. It also provides convenient and low-cost typesetting for the Society's publications.

However, VP: Admin Ken Smith said that **the newspaper** has misquoted himself and others on issues which concern the Society, and that he believes it is at times "Irresponsible in its journalistic practice". Blue & Gold Chairman George Klekner-Alt said he too has been misquoted several times, and that while one of the Slave Auction dancers had asked George that her picture not be used, it was printed in the paper.

George put forward a motion recommending that the sponsorship be withdrawn and **the newspaper** be required to move after the current agreement expires in September.

Much discussion followed. Communications Chairman John Byrne pointed out that this could ruin one of the Society's good business relationships, and said that a change of editors next year should clear up any "potential personality conflicts". President Gary Jones said that writing a letter to the editors stating the Society's grievances would be a considerate move. Yearbook Editor John Voss said that while the Eng Soc should continue to keep a close eye on **the newspaper's** reporting, it shouldn't propose their eviction just because of some alleged misquotes.

The motion was defeated and **the newspaper** will be allowed to remain.

Blue and Gold

• George Klekner-Alt reported that the last slave auction was a roaring success, and that a donation of "at least $1,000" will be going to the Knights of Columbus Boys' Camp.

• Mechanical won the chariot race, and George offered his sympathy to the two girls who were injured during the race. Two changes to the race rules were proposed:

First Year didn't win the Chariot Race.

1) the trophy must be returned 72 hours before race time

2) a new verse about Mario's Bakery is added to the Godiva hymn.

Fourth Year

Arun Channon reminded everyone that Grad Ball is on March 15 at Hotel Toronto and that tickets are now on sale. The Dress and Deportment lecture is on Tuesday, February 26 at 1:00 p.m. in GB120, and all fourth year students should attend.

Professional Development

Steve Landsberg proposed a change to the Society's constitution: "This committee (professional development) shall appoint a member of Council who shall be responsible for any communication between the Engineering Society and other engineering societies across Canada."

The motion was carried, and has to be passed again at the next full Council meeting to finalize the change.

Communications

• John Byrne reported that Toike Editor Bob Moult had met with Dean Slemon, and that the Dean had encouraged Bob to simply ignore the feminists' actions with respect to the paper. The next makeup will be in the office on Friday, February 29, for a Toronto Star parody.

• Treasurer Siobhan Keogh proposed a motion that Toike makeup expenses be limited by Council. John Byrne said he was against setting a ceiling, and since the editor was well within budget his makeup costs shouldn't be overly restricted.

VP Ken Smith stated that makeup costs should not be 20% of the total Toike production costs. Steve Landsberg replied that a publication's success can't be measured by its profit margin, and that other factors have to be considered. Stephen Roberts said that the Toike's strong financial status is not due to the editor, but rather to the excellent work of Business Manager Avi Zimmerman.

Discussion was ended and the motion passed. The Toike will be limited to a makeup subsidy of $2.50/head with a ceiling of $100 per makeup, regardless of the Toike's financial status.

Social

Elain Campbell reported that Cannonball finances were not finalized yet, but that losses should be about $700. The Women's Dinner will be held on February 26 with a cost of $10 for a hot and cold buffet and wine.

cont'd next page

Elections

Nominations for candidates running for positions as officers of the Engineering Society opened at noon on Tuesday, February 5 and close at noon Friday, February 29. Forms, including a copy of the elections regulations may be be picked up in the Eng Soc offices from Ella.

We need interested, interesting people to keep our Society's dynamic character alive. Any undergraduate engineering student may seek office. Brief descriptions of these positions follow, but the actual experience varies from person to person, year to year. An active, committed individual can do much more than the few items listed below.

President

The job of President is largely administrative. He is ultimately responsible for seeing that the Society functions effectively. The President represents the Eng. Soc. in all external affairs (e.g. eng. Alumni Association). Leadership and organizational qualities and the ability to delegate work are valuable in this role. Experience with the Eng. Soc. would be an asset, but is not essential. The President must be in Third or Fourth Year during his term of office (i.e. third year now).

Vice President: Administration

The V.P. Admin. is responsible for overseeing all financial and administrative affairs of the Society, including the Engineering Stores. He acts as an assistant to the President.

Vice President: Activities

The V.P. Activities is responsible for overseeing all cultural, technical, educational, athletic and social activities of the Society. This person should act as a catalyst to various Committees, making sure that things happen. This is a position for a person with lots of energy, enthusiasm and organizational talents. Being in Toronto over the summer would be helpful since the V.P. Activities co-ordinates the Summer Nights Orientation program.

Treasurer

The Treasurer keeps the books and financial records of the Society and reports regularly to Council. Preparing budgets with the V.P. Admin. and keeping a check on Society's finances provide a challenge. As interest or experience in bookkeeping or accounting is valuable.

Secretary

The Secretary prepares agendae, and takes minutes of all Executive Committee and Council meetings, and is responsible for the maintenance of Society records. This is a less demanding office that provides a great opportunity to learn more about Eng. Soc.

Interested? Why not run? It costs nothing to run, and you have a year of fun, new friends, frustration (just a bit) and great experience to gain.

For further information, call or visit the Engineering Society Offices (20 St. George St., 3rd floor) 978-2917. Hope we hear from you soon!

Older Eng Soc News

In a lively meeting on January 15, the Eng Soc Council discussed the spring budget, the OFS fees increase, tbe Toike Oike and other burning issues.

President's Report

- Gary Jones reported on Arts & Science dean Kruger's complaint about an impromptu LGMB concert in Con Hall during a PSY 100 lecture.

- The bill of $1,903 for damages to the SAC building during orientation is still unsettled, but Dean Slemon is acting as mediator. Gary said the Society can only afford to cover about $750 of this.

- The policy on access to the offices was clarified:

1) Anybody authorized to have a key is respoonsible for the actions of anyone they allow onto Society property;

2) Any others on Society property outside of Stores hours are trespassing, unless authorized by some bigher authority.

Treasurer

Siobban Keogh presented the proposed budget and answered questions about past and future expenses. The spring budget was passed as presented.

SAC

- Mike Nettleton spoke about the proposed OFS fees increase from $1.50 to $3.00. After considerable discussion, Council decided that the Eng Soc doesn't approve of the increase, and recommended that engineers vote against it.

- SAC has been discussing the Toike Oike. Tbe Women's Commission spent $50 to help publish a leaflet against the paper, and there is a motion to withdraw all SAC advertising until the Eng Soc adopts a formal Toike policy.

The Toike already has a formal policy, and SAC hasn't advertised in it this year. Council passed two motions, one reaffirming the present policy and condemning the actions of SAC, and the other recommending that SAC do a survey of student opinions about the Toike.

continued

SAC

Vic Aharonian reported on recent activities at SAC:

- Nominations for the SAC elections are open until Friday, February 29.
- SAC has not yet adopted an official stand with respect to the Toike.
- The issue of allowing the sexual education centre to distribute information on tbe subject of abortion is being considered. Much discussion followed, with tbe general consensus tbat this is outside the Eng Soc's terms of reference and that tbe Society should bave "no comment" on this issue. A motion was passed deferring discussion until the next meeting.

Faculty Council

- Rob Anderson reported that student attendance at the last two full council meetings was quite poor, and called for better turnout in tbe future.
- Each Eng Soc committee is expected to submit a Year-End Report before the next Council meeting.

Employment Committee

Dave Neale reported that approximately one third of the frosb took part in tbe employment seminars. He also stated tbat tbe results of the summer employment surveys are now available at tbe Placement Centre. He reminded reps that job openings are posted in the Engineering Stores as well as in tbe Placement Centre.

Next Meeting

The next meeting of Council is the joint Council meeting, whicb is tbe last for this year's and the first for next year's elected members. All students are invited to attend.

Communications

- John Byrne announced a proposed survey of other engineering societies' publications.
- Yearbooks will be available by mid-April for only $2.50. Editor John Voss reminded class reps he was counting on tbem to sell tbe books.

Professional Development

- Steve Landsherg reported on the Canadian Council of Engineering Students (CCES) conference. It was agreed that each university should appoint a liason officer for communications with the otber societies across the country.
- U of T will be sending a delegation to the engineering education conference to be held in Toronto in early May.

Fees Referendum Results

Engineering Society fees for 1980-81 will be $16, given Governing Council approval of our recent referendum. Of approximately 2400 undergraduate engineering students, 408 registered to vote; a 17% turnout. Of these, all voted on tbe question of tbe Eng Soc fees increase and 340 approved (83.3%). Only 405 voted on the question of a fees increase for tbe Engineering Atbletic Association, with 303 approving (74.8%). Tbus E.A.A. fees will be $6 next year, for a total of $22 compulsory incidental fees (in addition to Hart House, SAC etc.).

Documentation on the referendum is now being prepared, and will be in the hands of tbe University administration by Monday, Febraury 11.

We would like to thank all those who took the time to vote on this matter, and for next year's Council, those of you who gave such overwbelming support to the increase.

Underground

cont'd from page 5

target date favoured surface works. In his opinion, geologists with non-engineering backgrounds bad misjudged tbe possibilities.

Mexico City, witb 10-16 m inhabitants, was anotber example given by Bergman of wbat could be done. Tbe city was running short of water and sewage facilities and could stroe only two days supply of food. A new urban development was planned for 100,000 people up to 80 km away, witb integrated communications, water and food stores.

Mexico City would then be redesigned for tbe remaining expanding population.

Energy savings of 50-70% are stated for a section of the University of Minnesota, built partially underground by cut-and-cover methods. An earth-sheltered bome, open to tbe air on one side, bas shown savings of 30-50%. Energy savings accure both in winter, from tbe need for less beating, and in summer from lower cooling requirements.

Experts are convinced that these advantages, can be obtained by using suhsurface space, say tbe organisers of Rockstore 80. But the first step is to create a global awareness of its potential. Much of the technology is already available and can be developed to meet demands. Reprinted Surveyor Dec/79

Adhesives

cont'd from page 3

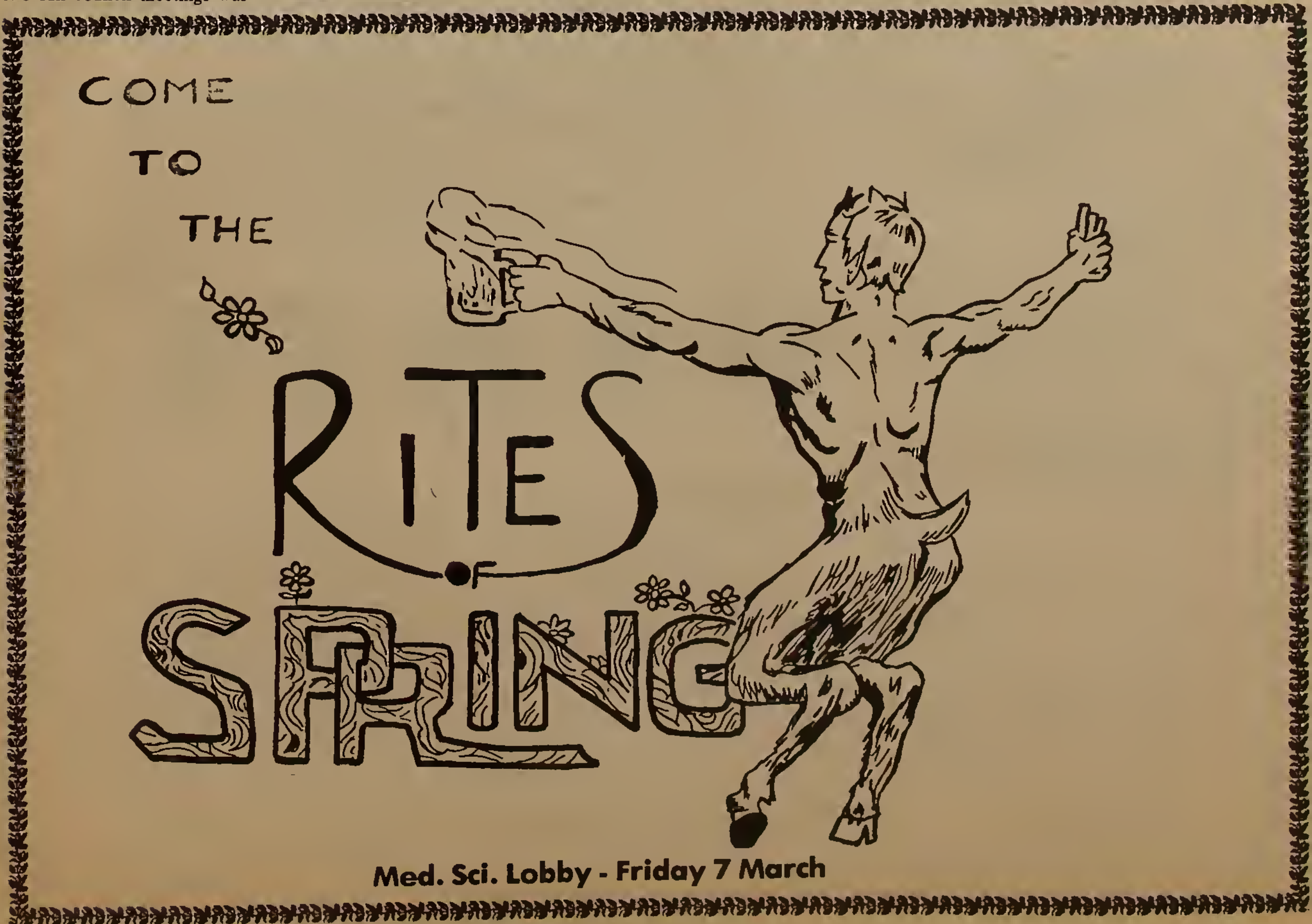
supplied as liquids or powders wbich polymerise on tbe addition of water. Formaldehyde adhesives release water during curing, so bigh bonding pressure is necessary.

Anaerobic adhesives, wbich are acrylic polyester resins, set in the absence of air (eg. in a tightly closed joint) but may require beat or a surface activator to accelerate curing.

Two-polymer adbesives are blends of thermosetting resins and either thermoplastics or elastomers. They are available in a variety of forms (powder, liquid, etc.) and may require beat and pressure for curing.

Elastomers. Elastomeric adbesives are based on natural or syntbetic rubbers. In general, they have low strengtb but bigh flexibility and are tberefore used to hond materials such as paper, fabrics and rubbers. They are available in a variety of forms.

Reprinted from CME Dec/79



TINY TOIKE PAGE

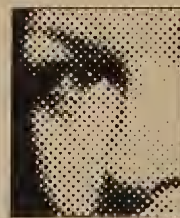
With the permission of the Drama Centre the UofT Engineering Society presents a look into the future

SKULE NITE
8T0
a musical revue
FEBRUARY 27 – MARCH 1
8:30pm Hart House Theatre
Reserved Seat Tickets available at;
Engineering Stores 20 St.George st.(978-2916)
Hart House Theatre Box Office University of Toronto (978-8668)
$3.00 & $ 3.50

SPECIAL RATES FOR GROUPS AND MARTIANS

PLEASE NO FLASHBULBS OR LASERS

Womens' Dinner Tonite
No Toike Editors Allowed



Toike Make-up
Friday, February 29, 1980

Remember the Text Editing System?

The excess parts are now being sold at thousands of dollars below cost. Parts available include tape drives, a video monitor, keyboards, and many assorted IC's. Any interested parties can either contact Dana Stonkus for a list of parts or leave a note in the CANNON box in the Engineering Society offices (3rd floor Old Metro Library)

Come see Ella's new tan

Eng Soc Nominations
Close this Friday.
So Do SAC Nominations
See Page 4

THE ENGINEERING ATHLETIC ASSOCIATION

PRESENTS

FOR THE FREE ENTERTAINMENT OF ALL ENGINEERS AND THEIR DATES

THE ANNUAL

S-DANCE

TO BE HELD IN THE COMMONWEALTH BALLROOM
OF THE HOLIDAY INN - DOWNTOWN
(CHESTNUT AND DUNDAS STREETS)

SATURDAY, MARCH 8th, 1980

7:00 P.M. - COCKTAIL RECEPTION
8:00 P.M. - AWARDS PRESENTATION
9:00 P.M. - 1:00 .M. DANCING

MUSIC TO BE PERFORMED BY
"ULTIMATE SOUND"

CASH BAR

ADMISSION IS FREE - TICKETS AT ATHLETIC STORES OR THE ENGINEERING STORES

COMPLIMENTARY BUFFET

SEMI-FORMAL